आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

SCHOOL OF SCIENCES

DEPARTMENT OF PHYSICS

MASTER OF SCIENCE (PHYSICS)

TWO YEAR PROGRAMME

[W. E. F. ACADEMIC SESSION: 2020 - 21]

IFTM UNIVERSITY
N.H.-24, Lodhipur Rajput, Delhi Road, Moradabad, Uttar Pradesh-244001
www.iftmuniversity.ac.in

आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश
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SCHOOL OF SCIENCES
DEPARTMENT OF PHYSICS

Study & Evaluation Scheme of Master of Science (Physics) [Session 2020-21]

Programme	**:**	**Master of Science (Physics)**
Course Level	**:**	**PG Course**
Duration	**:**	**Two Year (Four Semester) Full Time**
Medium of Instruction	**:**	**English**
Minimum Required Attendance	**:**	**75%**
Maximum Credits	**:**	**80**

Programme Outcomes (POs):
Students completing this program will be able to:

- Define the physical principles underlying a wide selection of physical phenomenon.
- Demonstrate the ability to plan, undertake, and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results.
- Understand the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, statistical mechanics and electricity and magnetism to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.
- Learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, condensed matter physics, nanoscience, lasers and electronics.
- Understand the basic concepts of certain sub fields such as nuclear and high energy physics, atomic and molecular physics, solid state physics, plasma physics, general theory of relativity, nonlinear dynamics and complex system.

COURSE STRUCTURE
M. Sc. – I Year (Physics)
SESSION (2020-21)

SEMESTER- I

S.N.	Course Code	Course Titles	Periods			EVALUATION SCHEME				Total	Credits
						Internal Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
1.	MPHY- 101	Classical Mechanics	3	1	0	20	10	30	70	100	4
2.	MPHY- 102	Mathematical Methods in Physics	3	1	0	20	10	30	70	100	4
3.	MPHY- 103	Quantum Mechanics	3	1	0	20	10	30	70	100	4
4.	MPHY- 104	Semiconductor Physics	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
5.	MPHY- 151	Physics Lab-1	-	-	8	-	-	50	150	200	4
		TOTAL	**12**	**04**	**08**	**-**	**-**	**-**	**-**	**600**	**20**

SEMESTER- II

S.N.	Course Code	Course Titles	Periods			EVALUATION SCHEME				Total	Credits
						Internal Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
1.	MPHY-201	Solid State Physics	3	1	0	20	10	30	70	100	4
2.	MPHY-202	Atomic & Molecular Spectroscopy	3	1	0	20	10	30	70	100	4
3.	MPHY-203	Computational Method & Programming Using 'C' Language	3	1	0	20	10	30	70	100	4
4.	MPHY-204	Statistical Mechanics & Thermodynamics	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
5.	MPHY- 251 MPHY-252	(1) Electronics Lab (2) Computer Programming Lab	-	-	4 4	-	-	30 30	70 70	100 100	4
		TOTAL	**12**	**04**	**8**	**-**	**-**	**-**	**-**	**600**	**20**

COURSE STRUCTURE
M. Sc. – II Year (Physics)
SESSION (2020-21)
SEMESTER- III

S.N.	Course Code	Course Titles	Periods			EVALUATION SCHEME				Total	Credits
						Internal Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	MPHY- 301	Nuclear & Particle Physics	3	1	0	20	10	30	70	100	4
2.	MPHY- 302	Advanced Quantum Mechanics	3	1	0	20	10	30	70	100	4
3.	MPHY- 303	Electromagnetic Theory & Electrodynamics	3	1	0	20	10	30	70	100	4
4.	MPHY- 304	Electronics-1 (Digital Electronics)	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
5.	MPHY- 351	Physics Lab-2	-	-	8	-	-	50	150	200	4
		TOTAL	**12**	**04**	**08**	**-**	**-**	**-**	**-**	**600**	**20**

SEMESTER-IV

S.N.	Course Code	Course Titles	Periods			EVALUATION SCHEME				Total	Credits
						Internal Exam			External Exam		
			L	T	P	CT	AS+AT	Total			
THEORY											
1.	MPHY- 401	Physics of Nanomaterials	3	1	0	20	10	30	70	100	4
2.	MPHY- 402	Electronics-2 (Fiber Optics and Optical Fiber Communication)	3	1	0	20	10	30	70	100	4
3.	MPHY-403	Elective*(Choose one Paper) 1.Microwave Communication 2.Physics of thin film and device Technology 3. .Nanotechnology 4. Elements of Material Science 5. Mobile and Satellite Communication	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
4.	MPHY- 451	Project work* & Viva-voce (*Seminar is also included)	-	-	8	-	-	100	200	300	8
		TOTAL	**9**	**03**	**8**	**-**	**-**	**-**	**-**	**600**	**20**

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (I Semester)

MPHY-101: Classical Mechanics

Objective: The objective of this course is to impart knowledge of fundamental concepts in the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation.

UNIT-I **(8 Sessions)**

Introduction, Conservation Principles (Laws), Mechanics of a Particle, Mechanics of a system of Particles, Conservation of Linear momentum, Conservation of Angular Momentum, Newton's Laws and their Limitations.

UNIT- II **(10 Sessions)**

Calculus of Variations, Hamilton's Variation Principle, D'Alembert's Principle and Lagrange's Equations, Deduction of Lagrange's Equations from Hamilton's Principle, General Features of the Orbits, Motion Under Inverse Square Law- Kepler's Problem, Rutherford Scattering.

UNIT-III **(10 Sessions)**

The Independent Coordinates of a Rigid Body, Euler Angles, Angular Velocity and Momentum, Equations of Motion for a Rigid Body, Euler's Equations, Torque Free Motion of a Rigid Body- Poinsot's Solutions.

UNIT- IV **(8 Sessions)**

Concepts of small oscillations, Expression of kinetic energy and potential energy for the problems of small oscillations, Frequencies of Free Vibrations.

UNIT-V **(6 Sessions)**

Hamiltonian Formulation of Mechanics, Basic Concepts, Motion of the system, Hamiltonians, Hamilton's Canonical Equations of Motion Deduction of Canonical Equations from Variation

Course Outcomes:

Students completing this course will be able to:

- Understand the discipline-specific knowledge in classical mechanics, covering the subjects: Basic concepts of classical mechanics, Newton's laws and applications, Lagrange's equations, Hamiltonian formulations and oscillation's.
- Learn necessary features of a problem like motion under central force, motion of a rigid body, periodic motion.
- Use critical thinking skills to formulate and solve quantitative problems in applied physics.
- Able to describe and understand planar and spatial motion of a rigid body, two body collisions, Rutherford scattering in laboratory and centre-of-mass frames.
- Explain rigid body dynamics, Euler's angles, Euler's theorem, moment of inertia tensor, eigen values, Periodic motion, oscillations.

Suggested Readings:

1. Classical Mechanics – N. C. Rana
2. Classical Mechanics – H. Goldstein
3. Mechanics – A. Summerfield
4. Introduction to Dynamics - Perceival and D. Richards
5. Classical Mechanics – J.C. Upadhyaya

Website sources:

- https://ocw.mit.edu
- https://cnx.org
- https://sites.astro.caltech.edu

- https://www.damtp.cam.ac.uk
- http://www.physics.usu.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (I Semester)

MPHY-102: Mathematical Methods in Physics

Objective: The aim of this course is to familiarize students about curvilinear coordinates, matrices, integral and Fourier transform, special functions and their various properties that are being widely used in Physics.

UNIT- I **(10 Sessions)**

Polynomials- Legendre, Hermite and Lagendre polynomials and their generating functions. Recurrence relations and special properties of Pn(x) as solution of Legendre differential equation, Rodrigues formula, orthogonality of Pn(x), associated Legendre polynomials (Introduction only).

UNIT -II **(8 Sessions)**

Bessel function of first kind, generating function, recurrence relations, Jn(x) as solution of Bessel differential equation, Expansion of Jn(x) when n is half and odd integer, Integral representation.

UNIT- III **(10 Sessions)**

Complex Variable: Function of a complex variable, Cauchy Riemann conditions, Cauchy's integral theorem (without proof), Cauchy's integral formula, Cauchy's Residue theorem.

UNIT- IV **(8 Sessions)**

Integral Transforms: Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of Initial value problems by using LT.

UNIT - V **(6 Sessions)**

Fourier series and Fourier Transform: Fourier series, half range expansion, arbitrary period, Fourier integral and transforms, FT of delta and Gaussian function.

Course Outcomes:

Students completing this course will be able to:

- understand Groups and representations : the mathematical aspects
- Characterize discrete symmetries as in solid state systems; relativity, generic Hamiltonian systems, quantum field theories etc.
- Integral equations and boundary value problems; usage in solving for physical systems. Elaborate the understanding of basic concept of complex variables and group theory.
- Analyse the wide range of special functions and transformations of different series.
- Describe various processes involved in understanding the behaviour of different systems through mathematics.
- Implement mathematical skills to solve problems in physics.

Suggested Readings:

1. Mathematical method for Physics by G. Arfken
2. Advanced Engineering Mathematics by E.Kreyszig
3. Special Functions by E.D Rainville
4. Special Functions by W.W Bell
5. Functions of complex variable by R.V.Churchill

Website Sources:

- https://www.intechopen.com
- http://www.physics.gla.ac.uk
- http://www.crfm.it/

- https://learn.lboro.ac.uk

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (I Semester)

MPHY-103: Quantum Mechanics

Objective: The objective of this course is to provide an understanding of the behaviour of the systems at microscopic (atomic and nuclear) scale and even smaller. Students would learn basic postulates and formulations of quantum Mechanics.

UNIT- I & II **(12 Sessions)**

Introduction & Review, Schrodinger wave equations, Eigen values & eigen vectors, Probabilistic interpretation, Normalization of bound and continuum state wave functions, Hermitian operator, Commutator algebra and uncertainty relation, Three dimensional potential well and Hydrogen atom.

UNIT- III **(12 Sessions)**

Angular Momentum: Communication relation involving angular momentum operator, Eigen value spectrum, Matrix representation of J, Addition of angular momentum, Clebsch- Gorden coefficients, Spin angular momentum, spin wave functions, Addition of spin and orbital angular momentum.

UNIT- IV **(8 Sessions)**

Matrix Formulation of QM- Diagonalisation of matrix, Dynamical and linear operator in matrix form, Dirac notations, Hilbert space, Liner harmonic oscillator in matrix formulation, Equations of Motion.

UNIT- V **(10 Sessions)**

Approximate Method- Time independent first and second order perturbation theory for non degenerate and degenerate levels, Variation method and its application for Helium atom, Stark effect, Dipole polarizability of ground state Hydrogen atom, Zeeman Effect.

Course Outcomes:

Students completing this course will be able to:

- Importance of quantum mechanics compared to classical mechanics at microscopic level.
- Interpret the wave function and apply operators to it to obtain information about a particle's physical properties such as position, momentum and energy
- Solve the Schrodinger equation to obtain wave functions for some basic physically important types of potential in one dimension.
- Understand the concept of spin, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion n relations.

Suggested Readings:

1. Quantum Mechanics by L.I. Schiff
2. Quantum Mechanics by Mathews & Venkatesan
3. Quantum Mechanics by Walton Greiner
4. Modern Quantum Mechanics by J.J. Sakurai
5. Introduction to Quantum Mechanics by E. Merzbacher.

Website Sources:

- https://ocw.mit.edu
- http://physics.weber.edu
- http://wcchew.ece.illinois.edu

- https://chem.libretexts.org
- https://ww2.odu.edu
- http://www.pas.rochester.edu
- https://en.wikipedia.org/wiki
- http://www-personal.umich.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (I Semester)

MPHY-104: Semiconductor Physics

Objective: The objective of this course is to give knowledge about semiconductor physics and explain the working and applications of basic devices, including transistors, amplifiers, BJT's and FET's, MOSFETs.

UNIT- I **(10 Sessions)**

Conduction Mechanism in Semiconductor

Classification of semiconductors, Elemental and compound semiconductor, Direct band and indirect band gap semiconductor, Charge carriers in extrinsic semiconductors, Carrier concentration, Fermi level, Electron and hole concentration at equilibrium, Temperature dependence of carrier concentration, , Drift of carriers in electric and magnetic fields, Conductivity and mobility, Drift and resistance, Effect of temperature and doping on mobility, Hall effect Diffusion of carries in semiconductors, Diffusion processes, diffusion and drift of carriers, Diffusion and recombination, Continuity equation

UNIT- II **(8 Sessions)**

Bipolar Junction Transistor

Transistor current components, CB, CE, CC configuration, Input Output Characteristics, Early Effect, Graphical Analysis of the CE configuration, Ebers-Moll Model, Transistor as a switch.

UNIT - III **(8 Sessions)**

Bias Stability and Hybrid Parameter

Stabilization against variation in Ico, V_{BE} and β, Stability factors S, S′ and S″, Transistor load line analysis, Method of transistor biasing: Base bias, Emitter bias, Mixed type bias and Voltage divider bias.

Transistor Hybrid model, h parameters, Analysis of transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model.

UNIT - IV **(10 Sessions)**

Field Effect Transistors

Construction and characteristics of JFET, transfer Characteristics, FET small signal mode, measurement of gm and rd, JFET fixed bias, self bias and voltage divider configuration , FET as voltage controlled resistor, JFET source- follower (common- drain) configuration , JFET Common – Gate configuration Depletion and enhancement type MOSFETs.

UNIT - V **(8 Sessions)**

Feedback amplifiers: Classification of Amplifier, feedback concept, Negative feedback amplifier, Analysis of feedback amplifier, Voltage Series feedback, Current series feedback, Voltage Shunt feedback, Current shunt feedback Nyquist Criterion for stability of feedback amplifier.

Course outcomes:

Students completing this course will be able to:

- Express the atomic structure of solids.
- Describe various properties of semiconductor materials using mathematical equations.
- Analyse the characteristics and theories in semiconductor materials in terms of crystal structures, charge carriers and energy bands.
- Understand Input Output Characteristics of Bipolar Junction Transistor
- Construction and characteristics of JFET, FET, MOSFET.
- Amplifiers, their Classification of Amplifier and concept of feedback in amplifiers.

Suggested Readings:

1. Solid State Electronic Devices by B.G. Streetman.
2. Integrated Electronics by J.Millman and C.C. Halkias.
3. Electronics Devices and Circuit Theory by R.L. Boylested and L. Nashelysky.
4. Electronic Devices and Circuits by Balbir Kumar and S.B. Jain.
5. Physics of Semiconductor Devices by S. M. Sze.

Website Sources:

- https://shodhganga.inflibnet.ac.in
- http://www.eenadupratibha.net
- http://staff.utar.edu.my
- https://parthoduet.files.wordpress.com
- https://www.vssut.ac.in
- https://www.tutorialspoint.com
- https://www.electronics-tutorials.ws
- https://www.elprocus.com
- https://en.wikipedia.org

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (I Semester)

MPHY-151: Physics Laboratory – 1

Objective: The main goal of this course is to share the knowledge to the students about the Experiments. The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.

List of Experiments **(20 Sessions)**

1. To study the amplitude modulation and determine modulation index.
2. To study the frequency modulation and de modulation.
3. To study and Plot the V-I characteristics of Photo Voltaic Cell (Solar cell).
4. To calculate the Hall coefficient and the carrier concentration of the sample material.
5. To determine e/m the specific charge of an electron by magnetron method.
6. To study the frequency variation in Hartley oscillator.
7. To study and design the ripple counter.
8. To design T type and π type attenuators for 20 DB (decibel attenuation).
9. To study the characteristics of SCR and its application.
10. To study of Active filter using Op-amp.

Course outcomes:
Students completing this course will be able to:

- Attain practical knowledge of basic electronic circuits and components by performing experiments in laboratory.
- Determine modulation index.
- Plot V-I characteristics of photovoltaic cell.
- design T type and π type attenuators
- Understand frequency variation in Hartley oscillator

Suggested Readings:

1. Solid State Electronic Devices by B.G. Streetman.
2. Integrated Electronics by J. Millman and C.C. Halkias.
3. Electronics Devices and Circuit Theory by R.L. Boylested and L. Nashelysky.
4. Electronic Devices and Circuits by Balbir Kumar and S. B. Jain.

Website Sources:

- https://www.niser.ac.in
- https://eceagmr.files.wordpress.com
- https://www.electronics-tutorials.ws
- https://www.tutorialspoint.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-201: Solid State Physics

Objective: This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools.

UNIT -I **(8 Sessions)**

Band Theory of Solids: Density of states, K-space, Bloch wave, Bloch theorem, The Kromig-Penny model, origin of energy gap, Brillouin zones, Number of wave functions per energy band, Motion of electrons in one dimensional- according to band theory, Distinction between metals, insulators and intrinsic semiconductors.

UNIT-II **(10 Sessions)**

Theory of Dielectrics, Piezoelectricity and Ferroelectrics: Explanation of Polarization, Dielectric constant, Local electric field, Dielectric polarizability, Clausius-Mossoti Relation, Types of polarizability, Frequency dependence of dipolar polarizability, Calculation of Ionic & Electronic polarizability, Total polarizability, Measurement of dielectric constants. Piezoelectricity, Ferro electricity, Theories of ferroelectricity, Dielectric behavior above Tc, Spontaneous polarization below Tc, Ferroelectric Hysteresis, Applications of ferroelectrics.

UNIT: III **(10 Sessions)**

Magnetism: Introduction, Classification of magnetic materials. Diamagnetism: Lagevin's classical theory of diamagnetism. Paramagnetism- Origin of permanent magnetic moments in paramagnetism, Lagevin's classical theory of paramagnetism. Weiss theory of paramagnetism, comparison of theory with experimental results. Paramagnetism at low temperature. Ferromagnetism, Antiferromagnetism and ferrimagnetism: Weiss theory of ferromagnetism, ferromagnetic domains, Bloch wall, Neel's model of ferrimagnetism

UNIT: IV **(8 Sessions)**

Photoconductivity & Luminescence; Photoconductivity: Photoconducting materials, Electronic transitions, Photoconductors, Absorption and Excitation, Trapping and capture, Recombination, Life time, Photosensitivity, Capture cross section, Simple model of photoconductor, Excitation, Absorption. Excitation across the gap, Trapping and its effects. Luminescence: Types of luminescence, Excitation and emission, Decay mechanism, Thallium activated alkali halides, sulphide phosphors.

UNIT : V **(6 Sessions)**

Superconductivity: Basic Concept, Occurrence, Meissner effect, Critical field, type-I, type-II superconductors, Critical currents, Thermodynamics of super conducting transitions, London equations, Coherence length, London penetration Depth, BCS theory of superconductivity, High Tc super conducting materials.

Course Outcomes:

Students completing this course will be able to:

- Understand the elementary lattice dynamics and its influence on the properties of materials.
- Understand the Bloch theorem, The Kromig-Penny model.
- Understand the concept of reciprocal space lattice and know the significance of Brillouin zones.
- Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids.
- Understand Photoconductivity & Luminescence.
- Understand the basics of phase transitions and the preliminary concept of superconductivity in solid.

Suggested Readings:

1. Introduction to Solid State Physics by C. Kittle.
2. Solid State Physics by A.J. Dekkar.
3. Introduction to solids by Azaroff.
4. Solid State Physics by S.L. Gupta & V. Kumar.
5. Solid State Physics by R. L. Katiyar.

Website Sources:

- https://lampx.tugraz.at
- http://www.egyankosh.ac.in
- https://www.phys.sinica.edu.tw
- http://bvcoend.ac.in
- http://www.irm.umn.edu
- https://en.wikipedia.org
- http://ecoursesonline.iasri.res.in

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-202: Atomic & Molecular Spectroscopy

Objective: The objective of this course is to impart knowledge of basics of atomic and molecular Physics that are needed for explanation of optical emission spectra of atoms and molecules.

UNIT-I **(10 Sessions)**

Bohr's theory and spectrum of Hydrogen atom: Types of spectra, Spectrum of H atom & Spectral series, Bohr's theory , Spectrum of H atom, Spin orbit coupling, Lamb shift, Isotopic shift ,fine structure of H and He+ lines, Hyper fine Structure & width of spectrum lines. Selection rules, Quantum numbers, space quantization, spectral terms and their notations.

UNIT-II **(10 Sessions)**

Spectra of Alkali and Alkaline elements, Series in alkali spectra, Ritz combination principle, spin orbit interaction, Doublet structure in alkali spectra, Transition rules, Intensity rules, spectra of alkaline earth, elements, L-S & J-J coupling, selection rules, spectrum of He atom, spectral lines & their splitting.

UNIT – III & IV **(12 Sessions)**

Covalent, Ionic and Vander wall's interactions, Born oppenheimer approximation, Heitler-London theory of H2, LCAO treatment of H2+ and H2,Chemical binding, Selection rules, Nuclear spin and intensity alternation, Isotope effect, Classification of electronic states, Coupling of rotation and electronic motion, Un coupling phenomena, Electronic bands, Franck- Condon principle, Correlation diagrams for molecules orbital's, Derivation of ground state of H2 molecules.

UNIT- V **(10 Sessions)**

Raman effect, Raman spectra, Classical & Quantum theory of Raman effect, Pure rotational Raman Spectra, Vibration rotation Raman spectra, X-ray spectra.

Course Outcomes:

Students completing this course will be able to:

- Motivate the necessity of using quantum mechanics calculations for describing atomic and molecular processes.
- Difference between atomic emission spectroscopy and atomic absorption spectroscopy And Atomic spectrum.
- Understand Atomic emission / absorption spectroscopy.
- Understand Molecular spectroscopy, Anomalous Zeeman's effect and Lande splitting factor.
- Explain Molecular Spectra of diatomic molecules.
- Differentiate between Vibrational and Rotational energy levels.
- Understand Born oppenheimer approximation Heitler-London theory of H_2

Suggested Readings:

1. Introduction to atomic spectra- H.E White,
2. Spectra of diatomic molecules by Herzberg.
3. Atoms and molecules by M. Weissbluth.
4. Elements of Spectroscopy - Gupta Kumar & Sharma.
5. Introduction to Atomic and Molecular Spectroscopy by Vimal Kumar Jain

Website sources

- https://courses.lumenlearning.com
- https://www.khanacademy.org
- https://en.wikipedia.org
- https://arshadnotes.files.wordpress.com
- https://sahussaintu.files.wordpress.com
- https://www.britannica.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-203: Computational Method & Programming Using'C' Language

Objective: The aim of this course is to train the students to the basic concepts of the C-programming language. It helps to learn the fundamental programming concepts and methodologies that are essential to build C programs.

UNIT- I **(10 Sessions)**

Finite differences, Newton's formula for interpolation, Gauss, Stirling, Bessel's, Everett's formulae, divided differences, Newton's general interpolation formula, Lagrange's interpolation formula.

Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson 1/3 rules, Boole's and weddles rules, Newton-cote's formula, Euler-Maclaurin formula.

UNIT- II **(10 Sessions)**

Method of least square curve fitting, straight line and quadratic equation fitting, curve fitting of curves $y= ax^{b}$, $y= ae^{bx}$, $xy^{a}= b$ and $y= ab^{x}$.

UNIT – III **(8 Sessions)**

Numerical solution of ordinary differential equation, Euler, Picard and Runge- Kutta methods, Predictor and corrector method.

Unit- IV **(8 Sessions)**

Introduction to Database: - Definition, Characteristics, Types of Database, E-R Diagram.

Computer Network:-Types of Networks, Protocols, Internet (Intranet, Extranet), E-mail, E-Commerce

(Digital signature, Online Shopping, ATM/ Debit card, Credit card, Internet Banking).

Unit-V **(6 Sessions)**

Introduction to C Language:- History, Data types, Operators, I/O statements.

Control statements & Looping:- if-else, switch, return, go to, Jump statements, break, continue, comments. for, while, do-while, Arrays, Function, Definition of testing and debugging , types of program errors, testing of programs, , difference between testing and debugging, File Handling.

Course Outcomes:

Students completing this course will be able to:

- Identify situations where computational methods and computers would be useful.
- Given a computational problem, identify and abstract the programming task involved.
- Write the program on a computer, edit, compile, debug, correct, recompile and run it.
- Identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.

Suggested Readings:

1. Introduction to Information Technology, V. Rajaraman.
2. Computer Fundamentals by Anita Goel.
3. Let Us C by Yashvant Kanitkar
4. Introductory Method of numerical analysis by S.S.Shastri
5. Numerical Method by E. Balaguruswamy
6. Computer organization by Hamacher, Vranesic & Zaky

Website Sources

- https://www.lkouniv.ac.in
- https://legacy.essie.ufl.edu
- https://ncss-wpengine.netdna-ssl.com
- https://uomustansiriyah.edu.iq
- https://beginnersbook.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-204: Statsitical Mechanics and Thermodynamics

Objective: To learn the properties of macroscopic systems using the knowledge of the properties of individual particles.

UNIT - I (8 Sessions)

Macroscopic, Microscopic States & Statistical Ensembles: Macroscopic States, Microscopic States, Phase Space, Density distribution in phase space, Liouville theorem, Micro canonical, Canonical & Grand Canonical Ensembles.

UNIT-II (10 Sessions)

Applications of Statistical Mechanics: Maxwell- Boltzmann's Statistics, Quantum Statistics, Symmetric & Antisymmetric wave function, Gibbs paradox, Bose Einstein Statistics- Degeneracy and Einstein condensation, Femi-Dirac Statistics- Free Electron theory of Metals, Fermi energy, variation of Fermi energy with Temperature, Variation of specific heat with temperature.

UNIT-III (10 Sessions)

Basic Concepts and Laws of thermodynamics: Thermodynamic systems, thermodynamic variables, P-V diagrams, Zeroth Law of thermodynamics, first law of thermodynamics, second law of thermodynamics, third Law of thermodynamics (Kelvin Planck Statement II nd law of thermodynamics), Concept of Entropy, Enthalpy Reversible and in irreversible process, Joule's experiment, J-T cooling.

UNIT-IV (8 Sessions)

Kinetic theory of gases: Pressure extend by a perfect gas, some deductions for the pressure, Expressions for most probable speed, average or mean speed and mean square speed of molecules, degrees of freedom, law of equipartition of energy, near free path, Transport phenomena (viscosity, thermal conduction, diffusion), Brownian motion.

UNIT -V (6 Sessions)

Thermo dynamical Relationships: Thermodynamic potentials, Deduction of Maxwell's thermo dynamical relations by their corresponding potentials, their applications.

Course Outcomes:

Students completing this course will be able to:

- Understand the Connection between statistics and thermodynamics.
- Explain different ensemble theories to explain behavior of the systems.
- Explain fundamentals of statistical physics and thermodynamics as logical consequences of the postulates. The students able to elaborate the BE, FD and BE statistics.
- Deduce Maxwell's thermo dynamical relations.

Suggested Readings:

1. Elements of Statistical Mechanics by B.K. Agarwal.
2. Statistical Mechanics by K. Huang.
3. Elementary Statistical Mechanics by Kittle .

4. Heat & Thermodynamics by Brij Lal and N. Subramanyam.
5. Statistical Mechanics by R. K. Pathria.
6. Heat and thermodynamics by Mark W. Zemansky & Richard H. Dittman.

Website Sources

- https://www.uio.no
- https://en.wikipedia.org
- https://www.theorie.physik.uni-goettingen.de
- https://en.wikipedia.org
- https://en.wikipedia.org
- https://madeeasy.in
- https://www3.nd.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-251: Electronics Lab

Objective: The main goal of this subject is to share the knowledge to the students about the Experiments. The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.

List of Experiments **(20 Sessions)**

1. To determine the Value of electric charge by Millikan oil drop Method.
2. To observe the ON and OFF state of the transistor in an Astable Multivibrator.
3. To observe the stable state voltages of Bistable Multivibrator.
4. To observe the stable state and quasi stable state voltages in Monostable Multivibrator.
5. Study of Absorption Spectrum of Iodine vapour.
6. Study of adder, substractor, Integrator, Differentiator using Op-Amp.
7. To study the working of RS flip flop and JK flip flop.
8. To study the working of shift registors.
9. To study the negative feedback amplifier.
10. To study the frequency variation in Colpitts oscillator.

Course Outcomes:
Students completing this course will be able to:

- design and evaluate various multivibrators..
- design and evaluate various counters and registers.
- evaluate basic components of the digital circuits like flip-flops
- understand frequency variation in Colpitts oscillator.

Suggested Readings:

1. Introduction to Solid State Physics by C. Kittle.
2. Introduction to solids by Azaroff.
3. Solid State Physics by S.L. Gupta & V. Kumar.
4. Solid State Physics by R. L. Katiyar.

Website Sources:

- https://www.niser.ac.in
- https://eceagmr.files.wordpress.com
- https://www.electronics-tutorials.ws
- https://www.tutorialspoint.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) - I Year (II Semester)

MPHY-252: Computer Programming Lab

Objective: The main goal of this course is to share the knowledge to the students about the Experiments. The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.

List of Experiments: **(20 Sessions)**

1. Giving exposure to Windows environment.

2. Write simple batch program.

3. Introduction to text editing and word processing.

4. File and program management in windows.

5. Write small program using C language.

6. Net Surfing, use for Internet.

7. Creation and usage of E-mail account.

8. Write a program to calculate the sum of two numbers.

9. Write a Program to compare two numbers.

10. Write a program to check a number whether it is even or odd.

Course Outcomes:
Students completing this course will be able to:

- Know concepts in problem solving
- To do programming in C language
- To write diversified solutions using C language

Suggested Readings:

1. Computer Fundamentals by Anita Goel.
2. Let Us C by Yashvant Kanitkar
3. Introductory Method of numerical analysis by S.S.Shastri
4. Numerical Method by E. Balaguruswamy

Website Sources:

- https://www.programiz.com
- https://beginnersbook.com
- https://www.programmingsimplified.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (III Semester)

MPHY-301: Nuclear and Particle Physics

Objective: The objective of this course is to acquire knowledge in the content areas of nuclear and particle physics. Develop and communicate analytical skills in subatomic physics.

UNIT - I **(8 Sessions)**
Introductory Concept of Nuclei: Nuclear angular momentum, nuclear magnetic dipole moment and Electric quadruple moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Systematic of stable nuclei.

UNIT - II **(8 Sessions)**
Nuclear Disintegration: Simple theories of decay, Properties of neutrino, Non-conservation of parity and Wu's experiment in beta decay, Electron capture, internal conversion.

UNIT -III **(10 Sessions)**
Inter Nucleon Forces: Properties and simple theory of the deuteron ground state, Spin dependence and tensor component of nuclear forces, Nucleon- nucleon scattering at low energy, Charge-independence of nuclear forces, Many – nucleon systems and saturation of nuclear forces, Exchange forces, Elements of meson theory.

UNIT -IV **(10 Sessions)**
Nuclear Structure and Models: Fermi gas model, Experimental evidence for shell structure in nuclei, Basic assumption for shell model, Single- particle energy levels in central potential, Spin-orbit potential and prediction of magic numbers, Extreme single- particle model, Prediction of angular momenta, Parities and magnetic moment of nuclear ground states, Liquid drop model, Semi- empirical mass formula, Nuclear fission, The unified model.

UNIT -V **(6 Sessions)**
Particle Physics: Properties and origin, Elementary particles, Properties, classification, type of interactions and conservation laws, Properties of mesons, Resonance particles, Strange particles and Strangeness quantum number, Simple ideas of group theory, Symmetry and conservation laws, CP and CPT invariance, Quarks, Gell- Mann- Okubo mass formula.

Course Outcomes:
Students completing this course will be able to:

- Acquire basic knowledge about nuclear properties such as mass, spin, radius, mass defect, binding energy etc.
- Understand the characteristics of nuclear forces, exchange force and meson theory.
- develop the understanding of nucleon-nucleon interactions
- Develop the understanding of nuclear disintegration.
- Understand the various nuclear models.
- Learn about the concept of elementary particle, quarks and conservation laws.

Suggested Readings:
1. Nuclear Physics by Roy & Nigam
2. Introduction to Nuclear Physics by H. Enge
3. Theoretical Nuclear Physics by J.M. Blatt and V.F. Weisskopf
4. Theoretical nuclear and Subnuclear Physics by J.D. Walecka
5. Particle Physics An introduction by M.Leon

6. Group Theory in Subnuclear Physics by F.I. Stancu
7. Nuclear Physics by D C Tayal

Website Sources

- https://en.wikipedia.org
- https://fys.kuleuven.be
- http://oregonstate.edu
- https://cds.cern.ch
- http://physics-database.group.shef.ac.uk
- https://www.physics.umd.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (III Semester)

MPHY-302: Advanced Quantum Mechanics

Objective: The objective of this course is to impart knowledge of advanced level in quantum mechanics and to teach about various approximation methods in physics to calculate the approximate values of energy for various systems.

UNIT -I (10 Sessions)

Identical Particles: Symmetrization postulate, connection between spin and statistics, Pauli Exclusion Principle, wave function for Fermions and Bosons. Examples: Helium atom, Scattering of identical particles.

UNIT- II (10 Sessions)

Time dependent Perturbation Theory: First order perturbation, Interaction of an atom with electromagnetic field, transition probabilities, dipole approximation, Einstein A and B coefficients , Induced and spontaneous emission of radiations.

UNIT –III & IV (12 Sessions)

Relativistic Quantum Mechanics

Kelin- Gordon equation and its plane wave solution, Probability density in Kelin –Gorden theory, Dirac equation for free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field, Dirac equation for central field and spin orbit interaction, Energy levels of Hydrogen atom from the solution of Dirac equation, Covariant form of Dirac equation.

UNIT -V (10 Sessions)

Scattering Theory : Schrodinger equation for a free particle in three dimensions, expansion of plane waves in spherical harmonics, scattering by a potential, scattering amplitude and cross-sections, Born approximation, scattering by Yukawa and Coulomb potentials, concept of phase shifts, calculation of phase shifts from potentials, partial wave expansion of scattering amplitude.

Course Outcomes:

Students completing this course will be able to:

- Importance of relativistic quantum mechanics compared to non relativistic quantum mechanics.
- Understand field quantization and related concepts.
- Understand Identical Particles, Scattering of identical particles.
- Explain time dependent Perturbation Theory, First order perturbation, dipole approximation.
- Explain Kelin –Gorden theory, Dirac equation for central field and spin orbit interaction.
- Understand Born approximation, concept of phase shifts.

Suggested Readings:

1. Quantum Mechanics by A.K. Ghatak and S. Lokanathan.
2. Quantum Mechanics by P.M.Mathew and K. Venkatesan.
3. Quantum Mechanics by. L.I. Schiff
4. Introduction to Quantum Mechanics by E. Merzbacher
5. Quantum Mechanics by S. Gasiorowicz
6. Modern Quantum Mechanics by J. J. Sakurai

Website sources

- https://www.southampton.ac.uk

- https://en.wikipedia.org
- http://www.tcm.phy.cam.ac.uk
- https://www.cmi.ac.in
- http://www2.chem.umd.edu
- https://ocw.mit.edu
- https://www.hep.phy.cam.ac.uk
- https://www.uzh.ch

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (III Semester)

MPHY-303: Electromagnetic Theory & Electrodynamics

Objective: The aim of this course is to build up the basic mathematical concepts related to electromagnetic vector fields and to give knowledge regarding the concepts of electrodynamics.

UNIT-I **(10 Sessions)**

Electro statistics

Gauss' law and its application; Laplace and Poisson equations, boundary value problems.

UNIT-II **(10 Sessions)**

Magneto statics

Biot-Savart law, Ampere's theorem, Equation of Continuity, Electromagnetic Induction.

UNIT- III **(8 Sessions)**

Maxwell's Equation

Maxwell equation in free space and linear isotropic media, Displacement Vector, Scalar and vector potentials, Poynting theorem.

UNIT- IV **(8 Sessions)**

Electromagnetic Waves

Electromagnetic Waves in free space, In dielectric and In conductors, Reflection and Refraction, Polarization and dispersion (Fresnel's law, Interference, Coherence and diffraction) transmission lines and Guided waves or wave guides.

UNIT - V **(8 Sessions)**

Electrodynamics of a radiating System

Dynamics of charged particles in static and uniform electromagnetic fields, Retarded potentials Radiations from moving charges, dipoles.

Course Outcomes:

Students completing this course will be able to:

- Understand electric and magnetic fields and apply the principles of Gauss's law to electric fields in various coordinate systems.
- Identify the electrostatic boundary-value problems by application of Poisson's and Laplace's equations.
- Explain the Biot-Savart law, Ampere's theorem, Equation of Continuity.
- Understand the depth of static and time-varying electromagnetic field as governed by Maxwell's equations.
- Understand the electromagnetic waves, polarization and dispersion..

Suggested Readings:

1. Classical Electrodynamics by J.D. Jackson
2. Introduction to Electrodynamics - David j. Griffiths
3. Foundations of Electromagnetic theory by J.R. Reitz, F. J.Milford and R.W.Christy

4. Electrodynamics by S.L. Gupta, V. Kumar and S. P.Singh.
5. Electromagnetic Theory by U. A. Bakshi and A.V. Bakshi.

Website Sources

- http://site.iugaza.edu.ps
- https://eng.libretexts.org
- https://en.wikipedia.org
- https://www.photonics.ethz.ch
- https://ocw.mit.edu
- http://people.physics.tamu.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (III Semester)

MPHY-304: Electronics-1 Digital Electronics

Objective: To introduce students to the theoretical knowledge and develop practical skill in digital systems, logic systems microprocessor and electronic systems.

UNIT -I **(10 Sessions)**

Operational Amplifier Basic and Application: Review of Feedback, Linear Circuits, Op-Amp Basic, Inverting and Non inverting amplifiers, unity follower , summing amplifiers, integrator, differentiator, Op-Amp Specification-DC, Off –set parameter, frequency parameters, imperfection in Op-Amplifier application-multiple stage gain, voltage summing and subtraction , current controlled voltage source, voltage controlled current source, Rectifiers and limiters, Comparators and Schmitt Triggers, active filters.

UNIT-II **(10 Sessions)**

Digital Logic Gates: Symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL,TTL,ECL,MOSFET,CMOS), Transistor- Transistor Logic (TTL) , Single Input TTL Inverter (transfer characteristic), Multi – collector transistor ,Propagation delays, Diode logic, DTL NAND gate (transfer Characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation), MOSFET ,Logic Review of MOSFET, MOSFET Inverter with active load, MOSFET NOR and NAND gates, Complementary MOS (CMOS)- CMOS inverter, CMOS NOR and NAND, POWER dissipation in CMOS, Advantages/ Disadvantage of CMOS.

UNIT:III **(8 Sessions)**

Digital Electronics and Logic Gate: Binary , Octal ,Hexadecimal number system, Base conversion system, Bipolar and Field Effect transistor as switches, Basic digital logic gates(OR, AND ,NOT,NOR. NAND and Exclusive OR) XOR gate, Boolean laws and theorem, Sum of Product(SOP) and Product of Sum(POS) method, Karnaugh map, pair ,quad and octave, POS simplification, min term, max term.

UNIT-IV **(8 Sessions)**

Application of Digital Logic Gate: Half adder and Full adder circuit, multiplexers, de multiplexer, Flip flops and Registers- RS Flip Flop, T –Flip Flop, JK Flip Flop, JK Master Slave Flip Flop, Astable, Mono stable and Bistable multivibrators, Type of registers, serial- in- serial out, serial –in-parallel out, parallel–in- serial out, parallel –in-parallel out.
Counters and Convertors- Asynchronous and synchronous counter, Mod-3 and Mod-5 counter,shift counters, Digital to Analog Convertor-D/A converter ladder network, A/D converters.

UNIT-V **(8 Sessions)**

Microprocessor –Intel 8085 microprocessor architecture, interfacing devices, BUS timing, instruction set, simple illustrative program.

Course Outcomes:

Students completing this course will be able to:

- Understand Operational Amplifier and their Applications
- Fundamental designing concepts of different types of Digital Logic Gates: Symbols and truth tables, Classes of digital integrated circuits.
- Designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.

- Convert different type of codes and number systems which are used in digital communication and computer systems.
- Employ the codes and number systems converting circuits and Compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.
- Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
- Understand Counters, Convertors and Microprocessor.

Suggested Readings:

1. Electronic Device and circuit by R. Boylested and L. Nashdsky
2. Analysis and Design of Digital Integrated Circuit by Hodges, Jackson and Saleh.
3. Digital Principals and Implementation by A.P Malvino and D.P leach.
4. Op-Amp and Liner Integrated Circuit by Ramakant A. Gayakwad.

Website Sources

- https://www.electronics-tutorials.ws
- https://en.wikipedia.org
- https://web.mit.edu
- https://india.oup.com
- http://mgcub.ac.in
- http://media.careerlauncher.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (III Semester)

MPHY-351: Physics Laboratory-2

Objective: To expose students to electronic devices and their evaluation techniques. The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.

List of Experiments **(20 Sessions)**

1. To study the series pass regulated power supply and to calculate its Parameters.
2. To determine the value of Planck's constants h by Photo cell.
3. To determine young's modulus and Poisson's ratio of glass by Cornu's method.
4. To determine the energy band gap of semiconductor using four probe method.
5. To verify the Cos square law (Malus law) for Plane Polarized light with the help of Photo Voltaic cell.
6. To determine the Numerical Aperture of an optical Fibre.
7. To calculate the signal attenuation of optical Fibre.
8. Study of Analog to Digital convertor.
9. Study of Digital to Analog convertor.
10. To study attenuation constant (α), phase shift constant($\boldsymbol{\beta}$) and to study voltage distribution of transmission line.

Course Outcomes:

Students completing this course will be able to

- Evaluate value of Planck's constants
- energy band gap of semiconductor
- evaluate Numerical Aperture of an optical Fibre.
- Study Analog to Digital convertor.
- Study Digital to Analog convertor

Suggested Readings:

1. Analysis and Design of Digital Integrated Circuit by Hodges, Jackson and Saleh.
2. Digital Principals and Implementation by A.P Malvino and D.P leach.
3. Op-Amp and Liner Integrated Circuit by Ramakant A. Gayakwad.

Website Source

- https://www.niser.ac.in
- https://maheshgandikota.files.wordpress.com
- https://instrumentationlab.berkeley.edu
- https://www.cisco.com

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-401: Physics of Nanomaterial

Objective: To give exposure about various phenomenons of Nanoscience and Nano technology and to teach them about influence of dimensionality of the object at nanoscale on their properties.

UNIT-I **(10 Sessions)**

Introduction to Nanostructure Materials: Nanoscience & nanotechnology , Size dependence of properties, Moor's law, Surface energy and Melting point (quasi melting) of nanoparticles, Conducting polymers, Graphene.

Change band structure of nanomaterials: Change in energy gap, Density of Structure distribuation, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, and Variation of density of states with energy and Size of crystal.

UNIT-II **(10 Sessions)**

Quantum Size Effect: Quantum confinement, Nanomaterials structures, Two dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques,

UNIT-III **(8 Sessions)**

Characterization techniques of Nanomaterials: Structure and Size, Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM), and Atomic Force Microscopy (AFM).

UNIT-IV **(8 Sessions)**

Optical Characterization: Absorption- UV-ViS.-N.I.R , PL (Photo luminescence).

UNIT- V **(8 Sessions)**

Synthesis of Nanomaterials: Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)- Synthesis, Properties and Applications(LED, Solar cells, FET).

Course Outcomes:

Students completing this course will be able to:

- Explain the nano science and technology in light of quantum confinement.
- Understand various phenomenon's like quantum dot, quantum wire in light of Schrödinger equation.
- Explain various Characterization techniques of Nanomaterial.
- Understand the Synthesis of various nanomaterials by various techniques with proper understanding.
- Understand Optical Characterization: Absorption- UV-VIS.-N.I.R
- leads the students in their research work.

Suggested Readings:

1. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens.

2. Quantum Wells, Wires and Dots by Paul Harrison.
3. Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.
4. Introduction to Nanoscience and Nanotechnology by G.L.Hornyak , H.F.Tibbals, J. Dutta and J.J. Moore .
5. Carbon Nanotechnology by Liming Dai.
6. Nano material by A. K. Bandyopadyaya
7. Nano Science by Rakesh Kumar

Website sources

- http://www.nanophysics.pl
- https://www.nanowerk.com
- https://en.wikipedia.org
- https://shodhganga.inflibnet.ac.in

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-402: Fiber Optics and Optical Fiber Communication

Objective: To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.

UNIT-I **(10 Sessions)**

Ray theory of transmission and preparation of optical fibers

Propagation of light in different media: propagation of light in an optical fiber, Basic structure and optical path of an optical fiber, Acceptance angle and acceptance cone, Numerical aperture(NA) (General), Modes of propagation, Meridional and skew rays, Number of modes and cut-off parameters of fibers Fiber Fabrication Techniques: Chemical vapour deposition technique, Double crucible method.

UNIT-II **(10 Sessions)**

Losses and Dispersion in Optical Fiber

Fiber Losses: Attenuation in optic fibers, Materials or impurity losses, Rayleigh scattering losses, Absorption loss, Leaky modes, Bending losses, Radiation losses.

Dispersion in optical fiber : Electrical Vs. optical bandwidth. Bandwidth-length product, Intermodal dispersion, Mixing modes, Material chromatic dispersion.

UNIT-III **(8 Sessions)**

Light Sources and Detectors for Optical Fiber

Light Sources: Introduction, LED (Light Emitting Diode), Processes involved, structure material and output characteristics of LED, Fiber LED coupling, Bandwidth, Spectral emission of LEDs, LASERS : Operation types, Spatial emission pattern, Current Vs. output characteristics.

Detectors: Introduction, Characteristics of photo detectors (General), Photoemissive type, Photoconductive and photo voltaic devices, PN junction type, PIN photo diode, Avalanche photo diode (APD).

UNIT-IV **(8 Sessions)**

Fiber optic sensors, Communication systems and Modulation

Fiber optic sensors: Introduction, Fiber optic sensors, Intensity modulated sensors, Micro bend strain intensity modulated sensor, Liquid level type hybrid sensor, internal effect intensity modulated sensor, Diffraction grating sensors and Interferometric sensors.

Communication systems :Transmitter for fiber optic communication, High performance transmitter circuit LED – Analog transmitter, LASER transmitter, Digital laser transmitter, Analog laser transmitter with A/D conversion and digital multiplexing, Fiber optic receiver,

Fiber based modems: Transreceiver.

Modulation: LED analog modulation, Digital modulation, Laser modulation, Pulse code modulation (PCM), Intensity modulation (IM).

UNIT-V **(8 Sessions)**

Optical Fiber Communication and Measurements on Optical Fibers

Optical fiber communication systems: Introduction, Important applications of integrated optic fiber communication technology, Long haul communication, Coherent optical fiber communication, Principle of coherent detection.

Measurements on Optical Fibers: Introduction, Measurements of numerical aperture (NA), Measurements of Fiber- attenuation, Optical time Domain Reflectometry (OTDR), Measurements of dispersion losses and Measurements of refractive index, Cut-off wavelength measurement, Measurements of Mode Field Diameter (MFD), near field scanning technique.

Course Outcomes:

Students completing this course will be able to:

- Distinguish Step Index, Graded index fibers and compute mode volume.
- Explain the Transmission Characteristics of fiber and Manufacturing techniques of fiber/cable.
- Explain different types of Losses and Dispersion in Optical Fiber
- Understand Light Sources and Detectors for Optical Fiber
- Different Measurements on Optical Fibers

Suggested Readings:

1. Optical Fiber Communications: Principles and Practices by John M. Senior.
2. The Element of Fiber Optic by S.I.W. Meardon.
3. Optical Fiber Communication-by G. Keiser.
4. Introduction to Fiber Optics by A. Ghatak and Tyagrajan
5. Optical Fiber Communication by Joseph C. Palais
6. Fiber Optics by N.S. Kapany
7. Optical Fiber and Optical Fiber Communication Systems by S.K.Sarkar.

Website Sources

- https://technobyte.org
- https://shodhganga.inflibnet.ac.in
- http://aems.edu.sd
- https://en.wikipedia.org

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-403*: MICROWAVE COMMUNICATION

Objective: To build up the concepts of basics of microwave communications to modern communications.

UNIT-I **(10 Sessions)**

Microwave Devices: Klystrons amplifiers, velocity modulation, Basic principles of two cavity klystrons, Multicavity clystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and travelling wave tube (TWT),Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.

UNIT- II & III **(12 Sessions)**

Amplitude modulation, Frequency modulation , Maximum allowed modulation, ,Modulators and Balanced modulators, Square law demodulation, Frequency demodulation, Spectrum of an amplitude modulated signal, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, FM generation, Parameter variation method, Armstrog system.

UNIT-IV **(10 Sessions)**

Quantization of signals, Single side band modulation, Generating as SSB .VSB, CSS, modulation system Angle Modulation, Phase modulation, Relationship between phase and frequency modulation Multiplexing.

UNIT-V **(10 Sessions)**

Transmission and Radiation of signals: Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart, Single and double Stub matching, Time domain reflectometry, Telephone lines and cables, Radio frequency lines.

Course Outcomes:

Students completing this course will be able to:

- Understand the concept of various Microwave devices
- Explain Magnetrons, principles of operation of magnetrons
- Understand Amplitude modulation, Frequency modulation, modulators and demodulation.
- Explain Quantization of signals.
- To learnTransmission and Radiation of signals.

Suggested Readings:

1. Electronic Devices and circuit Theory by R. Boylested and L. Nashdsky
2. Principles of Communication Systems by H. Taub and Donald L. Schilling
3. Optoelectronics: Theory and Practice, Edited by Alien Chappal Microwaves by K.L. Gupta
4. Electronic communications by Dennis Roddy and John Coolen

Website Source:

- https://en.wikipedia.org
- https://www.electrical4u.com
- https://gradeup.co
- https://user.eng.umd.edu

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-403*: PHYSICS OF THIN FILMS AND DEVICE TECHNOLOGY

Objective: To teach the fundamentals of the scientific principles behind thin-film technology and device technology.

UNIT- I **(10 Sessions)**

Growth and Characterization of thick and thin film, Vacuum Science and Technology: Vacuum pumps (Diffusion and Rotational), Vacuum gauges (Penning and Pirini), vacuum seals and Unit of vacuum and range, Thickness measurements of films Talystep, quartz crystal microbalance, optical methods.

UNIT-II **(10 Sessions)**

Electrical conduction in thin films metals and insulators, determination of electrical parameters, Hall effect, TEP measurements, DLTS, thin film diodes, transistors and capacitors.

UNIT -III **(8 Sessions)**

Optical properties of thin films, determination of optical constants, ellipsometry, SERS, nonlinear optics of 2D structures, devices-optical fibers, optical switches.

Photo thermal converters, photo electrochemical cells. Transducers and sensors, thermal sensors, pyrometes, radiations sensors, pH sensors, gas sensor and strain gauges, multiplexing action, Piezoelectric, pyroelectric and ferroelectric properties of thin films, Use of piezoelectric properties in devices.

UNIT - IV **(8 Sessions)**

Optoelectronic devices-solar Cells, heterojunction lasers, photodetectors, electrochromic devices. Two dimensional structures and high speed quantum devices, semiconductor quantum wells, quantum Hall effect stepped super lattices, MOSFET, BET, HEMT, HET.

UNIT- V **(10 Sessions)**

Magnetic propertices of thin films, magnetic recording and storage. Superconducting properties of thin films, high T. superconductors, Josephson effect, SQUID and applications.

Course Outcomes:

Students completing this course will be able to:

- Understand various techniques to grow thin films.
- Study the mechanical, optical and electrical properties of thin films.
- Apply the concept of thin films in the fabrication of various electronic devices.
- discuss the differences and similarities between different vacuum based deposition techniques
- study Optoelectronic devices.
- learn Magnetic properties of thin films, high T. superconductors,
- discuss typical thin film applications.

Suggested Readings:

1. Handbook of thin film technology, L. I. Maissel and R. Glang. (McGraw-Hill).
2. Thin film phenomena, K. L. Chopra (McGraw-Hill).
3. Active and Passive thin film devices and applications,
4. T. J. Coutts (Academic Press).
5. Solid State Physics, H.Ibach and H, Luth (Norosa Publishers).
6. Thin films Solar Cells, K. L. Chopra, S. R. Das (Plenum Press).

7. Electronic Instrumentation and Measurement Techniques, W. D. Cooper (Prentice Hall).
8. Sensors and Transducers, M. J. Usher (Macmillan Publishers).
9. AIP Handbook for Modern Sensors, J. Fradon, (AIP).
10. Physics of Thin Films, Lckertova Plenum.

Website Source

- https://shodhganga.inflibnet.ac.in
- https://www.philliptech.com
- https://en.wikipedia.org

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-403*: NANOTECHNOLOGY

Objective: To provide an introduction to and an overview over nanotechnology, synthesis of nanoparticles and various analysis techniques.

UNIT- I
Low dimensional materials. Application in Electronics, communication, medicine etc. Electron states in a potential well, spherically symmetric potential, Coulomb potential and periodic potential. Tunneling through a potential barrier. Excitons, biexcitons, dark excitons.

UNIT- II
Clusters, Fullerenes, Semiconductor and metal clusters, cluster stability, Nanotube, Graphene.

Electron states in nanoparticles, effective mass approximation, weak confinement, strong confinement,
size dependent oscillator strength.

UNIT - III
Synthesis of nanomaterials (bottom up approach) by physical techniques. Introduction to vacuum techniques (pumps, gauges, materials). Physical vapour deposition, electron beam evaporation, sputter deposition, laser ablation, ion beam mixing, plasma deposition.

UNIT- IV
Synthesis of nonmaterial by chemical, biological and hybrid routes, Concepts of colloids, LaMer diagram, L.B. films, Miceller route, self assembly, biosynthesis, electrophoresis, immobilization in glass, zeolites, polymers.

UNIT - V
Analysis Techniques: UV-VIS-IR spectroscopy, Luminescence techniques, X-ray, electron and neutron, Diffraction, Small Angle X-ray and Neutron Scattering, photon correlation spectroscopy, Extended X-ray, Absorption Fine Structure (EXAFS), X-ray Photoelectron Spectroscopy, Auger Electron Spectroscopy.

Course Outcomes:
Students completing this course will be able to:

- Determine the nanotechnology and actual working areas and applications.
- Synthesis of nanomaterials by physical techniques
- Synthesis of nanomaterial by chemical, biological and hybrid routes knows which properties of materials must possess depending on application
- Recognizes new nanomaterials.
- Determine processes for nanomaterials nanothinfilms and coatings.
- classifies different materials and thin films depending on their application
- understand Analysis Techniques- UV-VIS-IR spectroscopy

Suggested Readings:
1. Physics of Low Dimensional Structures, J. H. Davis, (Cambridge Press),
2. Semiconductor Quantum Dots, L. Bajaj and S. W. Koch.
3. Low Dimensional Semiconductors, M. J. Kelly, Clarendon,

4. Characterization of Materials, J. B. Wachtman and Z.
5. H. Kalman, Butterworth-Heinmann, USA,
6. Experimental Phyysics, Modern Methods, R. A. Dunlop.
7. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, (CBS Pub.),

Website sources:

- https://worldwidescience.org
- https://en.wikipedia.org
- https://chem.libretexts.org

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)

MPHY-403*: ELEMENTS OF MATERIAL SCIENCE

Objective: To learn fundamental concepts and the principles of materials science.

UNIT - I **(10 Sessions)**

Short review of basic structures, Tetrahedral and octahedral sites and their properties and importance, substitutional and interstitial solid solutions (only definitions), coordination number and Pauling rules, Crystal Structures of metallic alloys, Ceramics, polymers, silicates, composite materials include structures such as NaCl, Rutile, flurite, Hexagonal and cubic zink Blende, glass.

UNIT - II **(10 Sessions)**

Concept of entropy, derivation of expression for configurationally entropy using concept of multiplicity,
micro and macrostates etc., free energies, chemical potential, derivation of various thermodynamical expressions, concepts of eqillibrium and metastability, Phase diagrams of elements, applications of thermodynamics, Clapeyron equations for phase transitions, vapor pressures, effect of temperatures, its importance to vacuum systems and materials evaporation for thin films.

UNIT -III **(8 Sessions)**

Defects in Materials : point defects, line defects (dislocations), surface defects (grain boundaries), volume defects (voids), defects formation energies, their impact on physical properties of materials, formation energies, defect creation and annihilation, thermodynamic aspects such as concentration and Interactions, stress fields.

UNIT : IV **(8 Sessions)**

Phase Diagrams : Concepts of solid solubility, Hume-Rothery rules, concept of formation of phase diagrams on basis of entropy and free energy changes for compositions, Phase diagrams of various categories.

Unit- V **(8 Sessions)**

Diffusion in solids : concentration gradients, steady state non steady state flow, Fick's laws, error functions, diffusivity (macroscopic and microscopic diffusion models), importance of diffusion for materials synthesis and processing, examples and applications such as oxidation, corrosion, carborization, decarborization, nitridation, Nernst-Einstein equation, concentration profiles, etc.
Heat Treatment and Phase transformations in solids : Variation of free energies, nucleation and growth, surface and volume free-energies, Quenching, Nucleation rate, growth rates derivation of related expressions.

Course Outcomes:

Students completing this course will be able to:

- study Atomic and Bonding Structures: Demonstrate understanding of different classes of materials and their atomic and bonding structures.
- Learn the Concept of entropy, applications of thermodynamics
- Explain Defects in materials: point defects, dislocations, grain boundaries and voids.
- Study diffusion in solids: Demonstrate an understanding of solid-state diffusion mechanisms.
- Study Phase Diagrams: Demonstrate an understanding of equilibrium phase diagrams and phase transformations.

- Mechanical Properties: Demonstrate an understanding of mechanical properties of engineering materials and fracture mechanisms.
- Heat Treatment and Phase transformations in solids
- importance of diffusion for materials synthesis

Suggested Readings:

1. Physical Metallurgy, Vol. 1 and Vol. 2 by R. W. Chan and P. Hassen North Holland Publishing Company, New York, 1983.
2. Materials Science and Engineering, V. Raghvan, (Prentice-Hall Pvt. Ltd.), 1989.
3. Introduction to Materials Science for Engineers,
4. J. F. Shackelford, (Macmillan Publishing Company, New York), 1985.
5. Physical Metallurgy, Smallman.
6. Thermodynamics, Swalin.
7. Physics of Semiconductor Device-Dekker,S.M.Sze.

Website sources:

- https://en.wikipedia.org
- https://www.tulane.edu
- http://www.physics.usu.edu
- https://sites.krieger.jhu.edu
- http://people.virginia.edu
- https://nptel.ac.in

Note: Latest editions of all the suggested readings must be used

IFTM University, Moradabad
Master of Science (Physics) Programme
M. Sc. (Physics) -II Year (IV Semester)
MPHY-403*: MOBILE AND SATELLITE COMMUNICATION

Objectives: To learn basic principles of mobile communication systems and Satellite Communication.

UNIT-I: (10 Sessions)

Cellular Concepts and Equalization

Cellular telephone system, frequency reuse, channel assignment and land off strategies, elements of cellular radio system design, switching and traffic, data links and microwaves, system evaluation, interference and system capacity, Improving coverage capacity; Fundamentals of equalization, space polarization,

UNIT- II: (10 Sessions)

Diversity, channel coding and GSM system for Mobile

Frequency and time diversity techniques, channel coding; service and features, GSM system architecture, GSM channel types, GSM frame structure, intelligent cell concept and applications; Features of handset, SMS, security; Interfacing of mobile with computer, application of mobile handset as modem, data storage device, multimedia device; Measurement of signal strength; Introduction to CDMA digital cellular standard.

UNIT- III: (8 Sessions)

Satellite Communication

Satellite orbits, frequencies, stabilization, orbital parameters, coverage area, work angle, Attitude and orbit control system, telemetry tracking and command power system; Satellite Link design: system noise temperature and GIT ratio, down link design, domestic satellite system; eclipse on satellite.

UNIT - IV: (6 Sessions)

Multiple Access Techniques

FDMA and TDMA, TDMA synchronization and timing, code division multiple access.

Applicability of CDMA to commercial system, Earth's path propagation effects; satellite services for communication – Weather forecasting, remote sensing, direct to home (DTH) TV.

Course Outcomes:

Students completing this course will be able to:

- Study Cellular telephone system and Fundamentals of Equalization
- Learn the basic physical and technical settings functioning of mobile communications systems
- describe the basic principles of mobile communication system
- learn Diversity, channel coding and GSM system for Mobile
- Describe the motion of satellite in the orbit.
- Study Multiple Access Techniques

Suggested Readings:

1. Mobile Cellular Telecommunication: William C. Y. Lee (MGH Inc., 1995)
2. Mobile communication: Jochen Schiller (2nd edition, Pearson Education, 2004)
3. Satellite Communication: T. Pratt, Wiley Eastern Publication
4. Satellite Communication: D. C. Agrawal, Khanna Publications, New Delhi

Website Source:

- https://www.pearsonhighered.com
- https://nptel.ac.in
- https://www.cet.edu.in
- https://www.tutorialspoint.com
- https://www.itu.int

Note: Latest editions of all the suggested readings must be used